THE EFFICACY OF DIELDRIN AGAINST WOOL DESTROYING INSECTS

by

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ABSTRACT

The efficacy of dieldrin as a protectant against the wool destroying insects, *Anthrenus flavipes* Lec. (woolly bear) and *Tinea pellionella* Linn. (case-bearing clothes moth) has been investigated. In very low concentrations (0·02—0·05 per cent on the weight of fabric), the insecticide offers adequate protection against both the insects. The effectiveness of treatment is not impaired by laundering (12 times) or drycleaning (12 times). The resistance to laundering and drycleaning is not, however, as satisfactory when the insecticide is applied from solution. The economics of utilization of dieldrin as a protectant against the wool destroying insects has been discussed in relation to DDT, and it is shown that the former insecticide is much less expensive.

Introduction

The importance of protectants against the ravages of wool-destroying insects is well recognized. The discovery of dieldrin, one of the newer chlorinated hydrocarbon insecticides, is a landmark in diversified fields of insect control. Kearns, Weinman and Decker[1] demonstrated the effectiveness of dieldrin in protecting wool against the larvae of black carpet beetle, *Attagenus piceus* Oliv. and webbing clothes moth, *Tineola bisselliella* Hum. Lipson and Hope[2] reported that treatment with dieldrin was effective against the furniture carpet beetle, *Anthrenus flavipes* Lec. and the Australian carpet beetle, *Anthrenocerus australis* Hope. Lipson and Hope [2,3], *Anon.*[4] and Lipson and McPhee[5] found that application of dieldrin on woollen fabric gave adequate protection against *A. piceus* and *T. bisselliella* and that the treatment was fast to solvent extraction and washing. *Anon.*[6] and Hueck[7] using *T. bisselliella* and *Anon.*[8,9] and Norton, Capelle and Edmond[10] using *A. piceus*, as test insects, found dieldrin effective. In the present paper, the results of investigations, carried out in this laboratory, on the efficacy of dieldrin as a protectant against the widely occurring species of wool destroying insects in India, the woolly bear, *Anthrenus flavipes* Lec. and the case-bearing clothes moth, *Tinea pellionella* Linn. have been described and the economics of treatment in relation to DDT estimated.

Materials and Methods

Woollen fabric—An all wool white worsted serge, 1·37 m wide, weighing 388 gms. per linear metre (Serge, White, Lining) was used in the experiments,

Dieldrin—Dieldrin emulsion (Dieldrex—18) containing 1·8 lb. of the insecticide per gallon and dieldrin technical were supplied by M/s Burmah Shell Oil Storage & Distributing Co. Ltd., New Delhi.

Test Insects—The woolly bear, *Anthrenus flavipes* Lec. and the case-bearing clothes moth, *Tinea pellionella* Linn. were used as test insects. The insects drawn from laboratory cultures were used in the experiments.

A. flavipes—The larvae were reared at 29±2°C and 70±10 per cent R.H. on 'barrack' blanket, impregnated with a twenty per cent solution in water of a mixture of equal parts of glucose and albumin. Larvae, twelve to fourteen weeks old, were used.

T. pellionella—The larvae were reared at 29±2°C and 70±10 per cent R.H. on all-wool worsted white serge, impregnated with a five per cent dispersion of brewer's yeast in water. Larvae, ten to twelve days old, were used.

Treatment of fabric—The woollen fabric was treated with different concentrations of dieldrin emulsion according to the method described by the Wool Textile Research Laboratory, Commonwealth Scientific & Industrial Research Organization, Australia[11]. The method consists in mixing requisite quantities of the emulsion with a small volume of water and adding to the dye bath at the boil. The fabric to liquor ratio was 1:10 at 4·5 pH. The treatment is continued till the emulsion is exhausted. This usually takes about 10 to 15 minutes. Treatments were also, separately, carried out in solutions of dieldrin in petroleum ether (b.p. 40—60°C), so as to leave requisite concentrations of dieldrin on the fabric. The pieces of the woollen fabric to be treated were immersed in the insecticidal solution (fabric to liquor ratio 1:10) for 15 minutes, occasionally pressed and agitated to ensure thorough soaking and 100 per cent hold up adjusted in a padding mangle. The treated pieces were dried at room temperature.

Laundering or drycleaning of treated fabrics—The fabrics treated with dieldrin, emulsion or solution, so as to obtain 0·02 or 0·05 per cent of the insecticide on the weight of the fabric, were repeatedly (three, six, nine or twelve times) laundered by the procedure adopted for Wash Wheel Test No. 2, described in the Second Report of Fastness Test Committee of the Society of Dyers and Colorists[12]. They were also drycleaned, separately, using white spirit as the solvent by the method[13] described in the same report.

Assessment of insectproofness—The effectiveness of dieldrin against the above wool-destroying insects was assessed by the free larval test method evolved in this laboratory. The method consists in liberating twenty five larvae of *A. flavipes* or ten larvae of *T. pellionella* for fifteen days, on strips (5·0 cm×2·5 cm) of woollen fabrics. The test fabric in the case of *T. pellionella* is impregnated with a five per cent dispersion of brewer's yeast in water. The tests are carried out in glass tubes (10 cm×4 cm) which are sealed at one end and covered by muslin, held in place by suitable rubber bands, at the other. The test strips are individually kept in glass tubes. There are six replicates for the treated fabric and a similar number for the untreated control. Four similar specimens of each set are kept, side by side, as humidity checks, and the weight of the test strips is corrected for moisture change in the fabric. At the end of the test period (fifteen days) the strips of woollen fabric

are freed of all loose material such as larvae, excrement and cast skins. The test strips are examined for (*a*) loss in weight due to larval feeding, (*b*) weight of excrement of the larvae, (*c*) survival of larvae and (*d*) visual damage. The assessment was carried out at 29±2°C and 70±10 per cent humidity. The effect of laundering and drycleaning on the residual insectproofness of the treated fabrics was also investigated.

Results

The results of experiments on the efficacy of dieldrin, applied from emulsion or as solution, as a protectant against *A. flavipes* and *T. pellionella* are summarised in tables 1, 2 & 2A. Figures 1 & 2 represent the method of assessment described by Lamb[14]. The per cent efficiency is calculated by applying the following formula:

$$E = \frac{L_c - L_t}{L_c} \times 100\ \%$$

Where E = per cent efficiency.

L_c = per cent loss in weight of fabric due to feeding in the untreated fabrics controls.

L_t = per cent loss in weight of fabric due to feeding in the treated fabrics.

TABLE 1

Resistance of woollen fabric treated with dieldrin to A. Flavipes and T. Pellionella

Insecticide	Treatment (Per cent of dieldrin on weight of fabric)	Loss in Weight % (mg.)		Weight of excrement mg.	Survival of Larvae %	Visual Damage
1	2	3	4	5	6	7
	TEST INSECT: *A. Flavipes*					
	0·0001	58·6	16·9	30·7	97	Severe
	0·0005	44·8	13·3	28·0	88	,,
	0·001	15·4	4·7	8·8	99	Slight
Dieldrin emulsion ..	0·005	14·1	4·2	5·3	99	,,
	0·01	9·4	2·7	1·5	52	Nil
	0·02	0·9	0·2	0·0	12	,,
	0·05	0·3	0·1	0·0	0	,,
	Untreated fabric*	57·5	18·1	31·6	100	Severe

TABLE 1—*contd.*

1	2	3	4	5	6	7
	0·00005	79·3	19·7	29·8	100	Severe
	0·0001	67·2	17·3	20·6	100	,,
	0·0005	39·6	12·6	16·2	100	Moderate
Dieldrin (dissolved in petroleum ether).	0·001	25·5	7·5	13·5	90	Slight
	0·005	0·5	0·2	0·0	0	Nil
	0·02	0·0	0·0	0·9	0	,,
	0·05	0·0	0·0	0·3	0	,,
	Untreated fabric*	88·9	27·8	38·1	100	Severe
	TEST INSECT: *T. Pellionella*					
	0·00001	66·8	17·3	27·7	90	Severe
	0·00005	43·6	11·7	15·7	75	Moderate
	0·0001	17·4	5·4	13·1	55	Slight
Dieldrin emulsion ..	0·0005	14·7	3·8	5·3	5	,,
	0·001	0·9	0·3	6·2	0	Nil
	0·02	0·4	0·2	0·1	0	,,
	0·05	0·0	0·0	0·0	0	,,
	Untreated fabric*	68·4	21·8	30·5	100	Severe
	0·00005	72·6	18·6	31·3	100	Severe
	0·0001	65·2	15·2	27·6	100	,,
	0·0005	36·8	11·7	21·2	100	Moderate
	0·001	28·2	6·0	18·0	90	,,
Dieldrin (dissolved in petroleum ether).	0·005	11·6	2·5	0·3	8	Nil
	0·01	0·7	0·2	0·2	0	,,
	0·02	0·0	0·0	0·0	0	,,
	0·05	0·0	0·0	0·3	0	,,
	Untreated fabric*	77·6	23·4	32·6	100	Severe

* The figures represent the average of the values obtained with the untreated fabric in the different sets of experiments,

TABLE 2

Effect of Laundering on the Insectproofness of Woollen Fabric Treated with Dieldrin

Insecticide	Treatment (Per cent of dieldrin on weight of fabric)	Number of times laundered	Loss in mg.	Weight %	Weight of Excrement mg.	Survival of larvae %	Visual damage
1	2	3	4	5	6	7	8
		Test Insect: *A. Flavipes*					
Dieldrin emulsion ..	0·02	3	0·5	0·1	0·0	10	Nil
		6	0·0	0·0	0·0	32	,,
		9	1·7	0·5	0·5	8	,,
		12	2·2	0·6	1·1	13	,,
	0·05	3	0·0	0·0	0·0	0	Nil
		6	0·6	0·1	0·0	0	,,
		9	2·5	0·7	0·7	6	,,
		12	0·8	0·2	0·5	5	,,
	Untreated fabric*		57·5	18·1	31·6	100	Severe
Dieldrin (dissolved in petroleum ether).	0·02	3	3·9	1·1	0·6	28	Nil
		6	2·5	0·8	1·7	58	,,
		9	13·2	4·1	6·8	68	Slight
		12	18·1	5·5	7·4	74	,,
	0·05	3	0·0	0·0	1·0	16	Nil
		6	0·4	0·1	1·3	27	,,
		9	9·2	2·7	4·8	55	Slight
		12	14·2	4·3	5·1	55	,,
	Untreated fabric*		88·9	27·8	38·1	100	Severe
		Test Insect: *T. Pellionella*					
Dieldrin emulsion ..	0·02	3	0·6	0·1	0·1	0	Nil
		6	0·2	0·1	0·0	0	,,
		9	1·0	0·4	0·2	18	,,
		12	1·9	0·7	1·0	30	,,
	0·05	3	0·0	0·0	0·0	0	Nil
		6	0·4	0·2	0·3	0	,,
		9	0·9	0·3	0·5	0	,,
		12	1·0	0·6	0·7	0	,,
	Untreated fabric*		68·4	21·6	30·5	100	Severe
Dieldrin (dissolved in petroleum ether).	0·02	3	0·6	0·2	0·2	0	Nil
		6	1·8	0·5	0·9	0	,,
		9	6·2	3·1	5·7	40	Slight
		12	10·1	3·9	6·9	66	,,
	0·05	3	0·0	0·0	0·2	0	Nil
		6	0·4	0·2	0·5	0	,,
		9	4·2	2·7	3·1	12	,,
		12	6·5	4·2	6·7	27	Slight
	Untreated fabric*		77·6	23·4	32·6	100	Severe

* The figures represent the average of the values obtained with the untreated fabric in the different sets of experimets.

TABLE 2A

Effect of Drycleaning on the Insectproofness of Woollen Fabric treated with Dieldrin.

Insecticide	Treatment (per cent of dieldrin on weight of fabric)	Number of Times Dryclean-ed	Loss in Weight mg.	Loss in Weight %	Weight of excre-ment mg.	Survival of larvae %	Visual damage
1	2	3	4	5	6	7	8
		TEST INSECT: *A. Flavipes*					
Deildrin emulsion ..	0·02	3	0·6	0·1	0·0	32	Nil
		6	1·1	0·3	0·0	36	,,
		9	0·0	0·0	0·3	29	,,
		12	0·3	0·1	0·1	26	,,
	0·05	3	0·0	0·0	0·0	0	Nil
		6	1·4	0·4	0·0	0	,,
		9	0·3	0·1	0·3	24	,,
		12	0·0	0·0	0·1	24	,,
	Untreated fabric*		57·5	18·1	31·6	100	Severe
Dieldrin (dissolved in petroleum ether)	0·02	3	2·8	0·8	2·0	61	Slight
		6	46·0	13·3	15·3	92	Moderate
	0·05	3	2·8	0·8	2·1	55	Nil
		6	14·5	4·6	7·1	76	Slight
	Untreated fabric*		88·9	27·8	38·1	100	Severe
		TEST INSECT: *T. Pellionella*					
Dieldrin emulsion ..	0·02	3	0·5	0·2	0·0	0	Nil
		6	0·8	0·3	0·2	0	,,
		9	1·2	0·5	0·2	10	,,
		12	1·0	0·5	0·3	0	,,
	0·05	3	0·0	0·0	0·1	0	Nil
		6	0·3	0·1	0·1	0	,,
		9	0·7	0·2	0·3	0	,,
		12	0·6	0·2	0·2	0	,,
	Untreated fabric*		68·4	21·6	30·5	100	Severe
Dieldrin (dissolved in petroleum ether).	0·02	3	8·2	2·4	2·0	8	Nil
		6	31·5	9·5	13·4	66	Slight
	0·05	3	2·0	0·6	0·8	10	Nil
		6	28·1	8·9	4·6	23	Slight
	Untreated fabric*		77·6	23·4	32·6	100	Severe

* The figures represent the average of the values obtained with the untreated fabric in the different sets of experiments.

Discussion

Efficacy of dieldrin—A fabric is considered insectproof against *A. flavipes* and *T. pellionella* if the visual damage is nil and the per cent weight loss and the weight of excrement do not exceed two and four mgms respectively. These target figures are taken into consideration only when the control fabric (untreated) records minimum of ten per cent loss in weight due to larval feeding and the weight of the excrement of the larvae is at least twenty mgms.

The results presented in table 1 and figures 1 & 2 show that dieldrin, applied from both emulsion and solution confers adequate protection at very low concentrations to the fabric against attack by *A. flavipes* and *T. pellionella*. It will also be observed from figure 2 that against *T. pellionella* the treatment of woollen fabrics with dieldrin is more efficacious when the insecticide is applied from the emulsion rather than from solution and it is reverse in case of *A. flavipes* (figure 1). Reason for this is not understood.

It will be noted from the results presented in tables 2 and 2A that the fabrics treated with dieldrin emulsion (0·02 or 0·05 per cent dieldrin on the weight of the fabric) and repeatedly laundered (twelve times) or drycleaned (twelve times) resist attack by the wool destroying insects. The fabrics treated with dieldrin from solution in concentrations similar to those used for the emulsion, however, do not resist insect attack when laundered nine times or drycleaned six times. This is perhaps due to some affinity of the insecticide to the wool when applied from the emulsion.

Toxic hazard—The Commonwealth Scientific and Industrial Research Organization, Australia[6] has reported that dieldrin-treated garments worn next to the skin cause no irritation or other unusual effect. The remarks of Dr. J. C. Ward of United States Department of Agriculture (USDA) quoted by Hueck[7] are of considerable importance. "The USDA is accepting for registration under the provision of the Federal Insecticide Fungicide and Rodenticide Act, dieldrin emulsions whose labelling bears directions for application of the chemical during manufacturing operations designed to leave 0·05 per cent$\pm$0·01 per cent of the chemical in woollen fabrics. Evidence was presented to the Department to show that such treated woollens withstood repeated laundering and drycleaning without appreciable loss of effectiveness and this coupled with the data from long term feeding experiments, was regarded as adequate evidence to show that the deposit could not be readily extracted from the impregnated fabrics and that the quantity which could be absorbed by the body from garments treated as directed would be non-injurious".

Economics of the treatments—The bare cost of dieldrin emulsion when used so as to obtain 0·05 per cent dieldrin on the weight of the fabric works out approximately, to Rs. 0·86 per hundred pounds of woollen material. The method thus appears very economical for the protection of woollen textiles against insect attack particularly since the treatment resists repeated laundering or drycleaning. Although treatment of woollen material with DDT (from emulsion) so as to leave 0·5 per cent of the insecticide on the material confers adequate initial protection, the resistance to laundering particularly to drycleaning is very much inferior to that conferred by dieldrin (unpublished work). The bare cost of DDT involved in the treatment works out to approximately Rs. 2·60

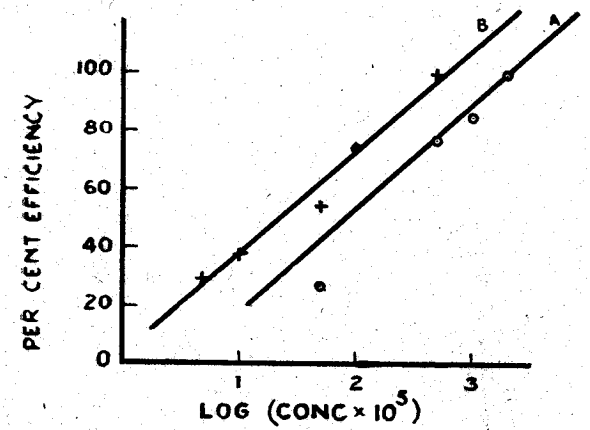

FIG. 1: EFFICIENCY OF DIELDRIN AGAINST A.FLAVIPES

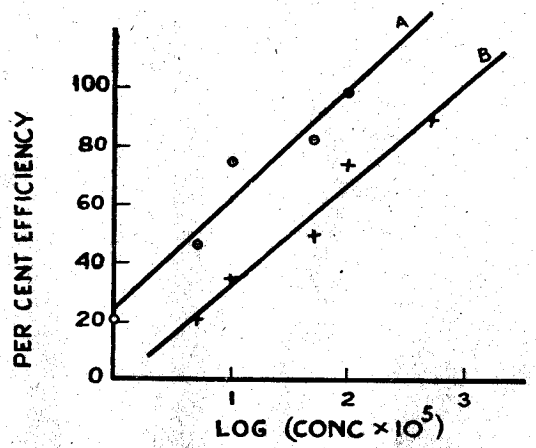

FIG. 2: EFFICIENCY OF DIELDRIN AGAINST T.PELLIONELLA

A :- DIELDRIN APPLIED FROM EMULSION
B :- DIELDRIN APPLIED FROM SOLUTION

per hundred pounds of woollen material. The cost of application of the insecticide is not known but it is reasonable to expect that it will be the same for both dieldrin and DDT.

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